is, however, in favour of their more intimate reptilian affinities. They are characterised externally by their covering of feathers, and by the fore limbs being developed to form wings. These wings, though primarily constructed for flight, in some birds perform other functions. In the Penguins they are employed for swimming, in the Ostrich to assist in running, whilst in the Apteryx and the Cassowary their condition is so rudimentary that they can be of no service to their owners. In the Night Parrot and the Weka Rails the wings are very much diminished.

Birds are divided into from seventeen to twenty well-marked groups, of which the Gallinæ, the order which contains the Pheasants, forms one which is more important in an economical point of view than any of the others, as it contains most of the domesticated species of birds, the ducks and pigeons being exceptions. The Game Birds, as the Gallinæ are commonly termed, may be divided into the following seven sections :—1. The *Pteroclidæ*, or Sand Grouse, birds which inhabit Africa and Western Asia. By some naturalists they are grouped with the Pigeons ; they, however, differ from them and agree with the fowls in laying coloured eggs, at the same time that the young ones run about directly they are hatched. There is one species, found in the steppes of Tartary, in which, unlike its allies, the hind toe is absent. In the year 1863 a flock of Sand Grouse spread over all Western Europe. Prof. Newton tell us, in the "Ibis," that not less than seven hundred individuals must have appeared. A few stragglers were seen for a short time afterwards. 2. The *Meleagridæ*, or Turkeys, are unfortunately so called, as they are in their wild state confined to Northern and Central America. Only three wild species are known, the most northern of which is said to be the parent stock of our domesticated form, although some of the evidence is in favour of the latter having sprung from the Mexican species. The Ocellated Turkey, from Honduras, is a particularly handsome bird. 3. The *Numididæ*, or Guinea Fowl, are represented in Guinea by one species. The four or five others are all confined to Africa ; of these, the elegant Vulturine Guinea Fowl, of which several specimens have been presented to the Zoological Gardens by Dr. Kirk, comes from Zanzibar. 4. The *Cracidæ*, or Curassows, are the representatives of the Game Birds in Central and South America. They will not nest in captivity here, perhaps because, as they are arboreal in their habits, it is not possible to give them suitable abodes. They are said to have been first introduced into Europe by the Dutch, from the island of Curassow, in the West Indies. In some species the cock and hen are identical in plumage ; in others very dissimilar. 5. The *Megapodidæ*, or Megapodes, are confined almost entirely to the Australian region. They are nearly allied to the Cracidæ. Their eggs are laid in the middle of a mound composed of earth and grass, where they are left to be hatched. Many eggs are laid, and the young ones are able to fly within twenty-four hours of leaving the egg. Their breeding habits have been well described by Mr. Bartlett, from examples which have laid in the Society's Gardens. By one species the mound constructed is as much as 15 ft. high and 60 ft. in circumference. The habits of one peculiar species, the Maleo of Northern Celebes, have been well described by Mr. Wallace. 6. The *Turnicidæ*, or Hemipodes, much resemble quails. They are mostly African, one species occurring in Andalusia. Their anatomy is somewhat peculiar. 7. The *Phasianidæ*, or Pheasants, are constituted by (*a*) the *Tetraonidæ*, or Grouse, inhabitants of the mountainous regions of Europe and Northern Asia. In all the species the legs, and in some the toes, are feathered. They do badly in captivity. The best known of them are the Prairie Fowl, Capercailzie, Black-cock, and Ptarmigan. (*b*) The *Perdicidæ*, or Partridges, are found in every part of the Old World. The Snow Pheasant of the Himalayas is one of the largest species. The Impeyan Pheasant, from the same locality, is a closely allied form. These birds are represented in America by (*c*) the *Odontophoridæ*, or Colins, sometimes called toothed Partridges, because the bill is slightly toothed. They are much more arboreal than their Old World representatives, and none of them attain a great size. (*d*) The *Phasianidæ*, or Pheasants proper, form about forty species, arranged in seven genera. The story runs that the common Pheasant was first brought from Colchis by the Argonaut, whence its scientific name, *P. colchicus*. The genera include the *Crossoptilons*, or Eared Pheasants of Northern Asia, of which there are four species : the true Pheasant, preserved in this country ; the *Thaumalea*, or Gold Pheasant, with its superb ally, the Amherst Pheasant of Central Asia, first made known from a specimen brought over by the Lady Amherst when returning from an embassy to the King of Ava. Further facts respecting its distribution have been obtained by Dr. John Anderson and Mr. Stone. The *Euplocami*, or Kaleeges, are represented by twelve species. They are intermediate between the Pheasants and the Fowls. A new species has been quite recently obtained by Mr. Gould from the interior of Borneo (*Lobiophasis*). *Gallus* is the name given to the genus which includes the Fowls, of which there are four species. The Jungle Cock of India is the wild ancestor of the domesticated bird ; others are inhabitants of Ceylon and Java. *Ceriornis* includes the Tragopans, which are peculiar in having horned appendages to the head. There are five species in this beautiful group. (*e*) The *Pavonidæ*, or Peafowls, are natives of the forest jungles of India, and such being the case it is strange that they so well resist the winters of our own country. *Polyplectron*, or the Peacock Pheasant, is an allied form ; it is aberrant, however, in that it is monogamous and lays only two eggs. The Argus Pheasant also belongs to the same family.

THE PROGRESS OF THE TELEGRAPH *

VIII.

MORE daring inventors, as we have seen, entered the field—Nott and Gamble, with a letter-showing telegraph ; Edward and Henry Highton, who produced an array of signal apparatus, in some cases evading the Cooke and Wheatstone patents by the use of nickel for the electro-magnet in place of soft iron. But formidable beyond all other competitors was the talented Alexander Bain, the Edinburgh watchmaker, who has contributed largely to the improvement of the telegraph by his singularly beautiful adaptations and chemical printing arrangements. Expensive litigation speedily followed, and the directors in most cases compounded with their opponents. Alexander Bain was made a director of the Company, and at the same time received 12,000*l.* for his chemical printer, and most of the other opposing patents became the property of the Company by special arrangements with the inventors. By means such as these a monopoly for a time was secured, even though it was purchased at an exorbitant price. Monopoly at that time represented commercial gain, and every aspiring inventor was sooner or later run off his feet by the powerful and wealthy corporation. Such is the early history of the introduction and opening of the Electric Telegraph as a means of the transmission of inland intelligence. The telegraphic connection of Great Britain with the Continent of Europe at this time was scarcely developed, the extent of electrical communication by the continental land lines being circumscribed.

This, however, thanks to further applications of science, is no longer the case. The planet is now girt by telegraphs. First, there is the "Great Northern,"

* Continued from p. 113.

stretching from London, the telegraphic centre of the world, by land and submarine circuits into Denmark, Norway, Sweden, and Russia in Europe, thence across the wilds of Siberia in Asiatic Russia to the Japanese Sea, and on to Japan, terminating within the tropics, at Hong Kong. Secondly, the "Eastern Telegraph," which, crossing the Bay of Biscay, reaches Lisbon, and thence threading its way under the dark blue waters of the Mediterranean Sea to Suez, reaches India by the Red Sea and Indian Ocean, and on to Ceylon (Point du Galle), joining the "Great Northern" at Hong Kong *viâ* Singapore. Thus by means of these two great systems a complete circuit of the continents of Europe and Asia is effected, the one within the limits of the tropics, the other bordering upon the Arctic circle, reaching as it does to 62° of north latitude. At Singapore the circuit is divided, a branch extending south to Sumatra, Java, and the continent of Australia,—Sydney, Melbourne, and Adelaide being reached; New Zealand being about to be included. Thirdly, there is the vast stretch of the South Atlantic Ocean traversed by the circuits of the "Brazilian Submarine," connecting Great Britain, *viâ* Lisbon, with Madeira, St. Vincent, and the continent of South America to Pernambuco. There it joins the coast submarine circuits of the "Western and Brazilian," extending north to Para and south to Bahia, Rio Janeiro, Rio Grand do Sul, and Monte Video in the River Plate, at which station, in connection with the local lines of the River Plate Company, it reaches Buenos Ayres, thence by means of the wires of the Argentine Republic, crosses the Andes into Chili and Peru. From Para the electric circuit is extended (Para and Demerara being now under completion), by way of the West India Isles, Jamaica, and Cuba, to Florida, there joining the extensive system of the United States Trunk lines; to San Francisco, west, and Newfoundland, east; and thence, by the circuits of the "Anglo-American" and "Direct United States" cable, crossing the Atlantic Ocean to Great Britain. Thus the New World is also encircled by two great systems, the one almost equatorial, the other within the higher degrees of northern latitude.

In dealing with submarine circuits the electrician has several matters to consider and accurately adjust, some of which will be more fully considered hereafter. First, there is the copper-conducting wire, its capacity according to the length of the circuit. Too small a conducting wire on a circuit of a given length would offer too great a resistance; too large a conducting wire would be equally faulty, induction increasing in greater proportion from its large superficial surface than its increased sectional area augments the speed. The exact sectional area of the wire has therefore to be determined; then for insulation, the best relative proportion in weight, and sectional measurement between the wire and that of the insulating material. Insulation, as is well known, may be obtained by a mere film of a non-conductor surrounding the wire. This is illustrated by the simple experiment of passing a weak voltaic current of electricity through an extended fine metallic wire immersed in a trough of water. Under ordinary circumstances it is but natural to suppose (water being a conductor) that there would be no insulation; not so; by the action of the current through the wire decomposing the water, a fine non-conducting film of hydrogen is developed surrounding the wire, which, with a strength of current adjusted to the resistance of the wire, will separate the water from the metallic conductor, perfect insulation being maintained. Destroy the balance between the current and the wire, and the hydrogen, evolved too rapidly by reason of electrical decomposition, accumulates upon the surface of the wire and, passing off in the form of small bubbles, destroys the insulation. This simple experiment demonstrates that insulation in the abstract sense may be obtained by a very thin covering of a non-conductor. It is, however, in practice mechanically unsafe to rely upon mere tissues of insulating material surrounding the conducting wire; a certain thickness is absolutely necessary for security. Every insulated core to be used for submarine purposes, to ensure integrity of manufacture, should be tested under pressure, so as to break down all mechanical imperfections in the coating of the insulating medium, before the cable is submerged. The determination of the dimensions of the insulator influences also

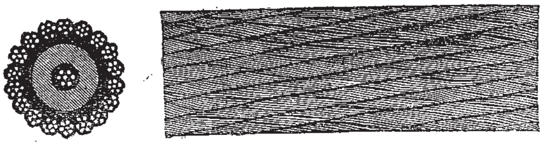
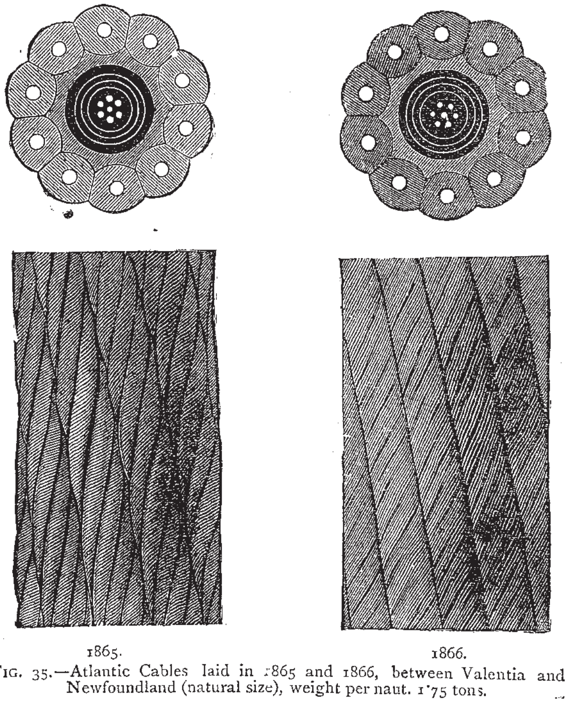


FIG. 34.—First Atlantic Cable, 1857 (natural size).

materially the inductive effect of the circuit; and when it is remembered that the best insulating material represents a cost of about 6*s.* per pound weight upon the wire, the close connection between science and pounds shillings and pence becomes at once apparent. The variations in weight per nautical mile of copper and insulation in some of the recent important cables are here given. The Atlantic main cables of 1865 and 1866: copper 300 lbs., insulation 400 lbs.; lengths each about 1,900 nautical miles. French Atlantic main cable, 1869: copper 400 lbs., insulation 400 lbs.; length about 2,600 nautical



1865. 1866.

FIG. 35.—Atlantic Cables laid in 1865 and 1866, between Valentia and Newfoundland (natural size), weight per naut. 1·75 tons.

miles. Falmouth and Lisbon, 1870: copper 120 lbs., insulation 175 lbs.; length about 800 nautical miles. Anglo-Danish Cable, 1868: copper 180 lbs., insulation 180 lbs.; length, 365 nautical miles. Hong-Kong—Shanghai, 1870: copper 300 lbs., insulation 200 lbs.; length, 1,100 nautical miles. China Telegraph, 1870: copper 107 lbs., insulation 140 lbs.; length, 1,632 nautical miles. British India Extension, 1870: copper 120 lbs., insulation 175 lbs.; length, 1,448 nautical miles. Eight important submarine circuits have here been summarised, and in six it will be found that the proportions in the weight per nautical mile between the copper and insula-

tion vary in an extreme degree. Thus there is found copper and insulation in the respective proportions by weight of 1 to 1, also 3 to 4, also 3 to 2, also 2 to 3, and also in the irregular proportion of 11 to 14. By these figures it appears that there is no accepted ratio, and every new cable seems to be constructed according to the electrical views of the designer, in some cases at an enormous cost, as compared with others of similar length and equal efficiency in transmitting power. Thus, by reducing the weight of material per nautical mile into an average money value, assuming for copper 1*s.* 2*d.* per lb., and insulation 6*s.* per lb., we obtain the following ratios :—

1,100 nautical miles :	copper	£16 0	insulation	£60
1,632 ,,	,,	6 5	,,	42
2,600 ,,	,,	23 10	,,	70
2,000 ,,	,,	16 0	,,	70

With such indiscriminate specifications there is certainly something left to discover, and the next few years may determine with some degree of accuracy the true proportions by weight to be adopted between the conducting wire and the external thickness of the insulator, to obtain the best practical results at the least expenditure of capital on a circuit of given length, worked with one of the sensitive recording instruments already brought under notice. As an example of the augmentation of speed upon a submarine circuit, according to the delicacy of the recording instrument employed, upon the Great Northern cable between England and Denmark, 365 nautical miles in length, with the most improved submarine morse, an average of seventeen words per minute was obtained; with the Wheatstone's automatic thirty words, and with the Thompson syphon recorder fifty words per minute are practically reached.

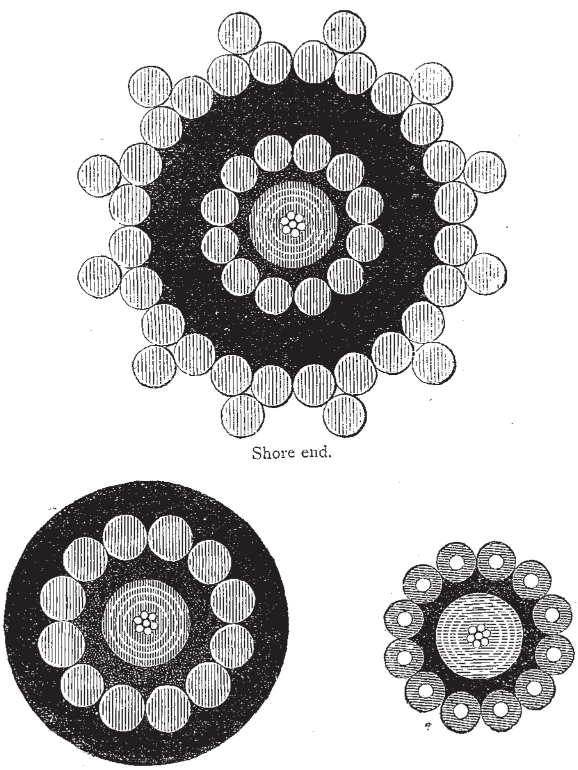


FIG. 36.—French Atlantic Cable laid between Brest and Island of Saint-Pierre, 1869.

For many years there has existed a divided opinion as to whether a light submarine cable, combining economy of construction with mechanical facilities of laying, is not the right system to adopt as against the heavy and more expensive form of iron covered cable. The light cable theory may be said to be based upon the opinion of the late Lieut. M. F. Maury, who through every opposition adhered in principle to light cables. His argument may be expressed in his own words: "You may snap a taut rope, but you cannot break a slack line." This remark may nautically be quite true, but electrically far from correct, for the following reasons. In submerged cables, speed is greatest upon the shortest line. Now, in deep-sea telegraphy, in the only circuits upon which a light cable could possibly be employed with any security against mechanical interruptions, two or three points come into play. Supposing a light cable were to be used over, say, a circuit of 2,000 miles, with an average depth of 1,500 fathoms, or about $1\frac{3}{4}$ miles. First, take the specific gravity of the light cable as compared with water, at what rate will it sink to the bottom? if not so adjusted as to sink at about one mile per hour (looking to the enormous sweep between the paying out steamer and the bottom of the ocean at the depth of $1\frac{3}{4}$ miles), it is more than probable that although you cannot break a "slack line," it may be so twisted and contorted by surface-currents and under-currents moving at various velocities or even in opposite directions as it slowly sinks to the bottom by reason of low specific gravity, that a very great length of cable may be paid out (as a slack line). Secondly, the cost of this increased mileage must be taken into account as compared with that of the heavier iron-sheathed cable upon which a mechanical strain can be placed to ensure more or less a "Bee" line. Thirdly, the speed of transmission through a submarine cable is inversely as the square of the length. Now, if this is practically correct, it is easy to determine whether the best commercial results will be obtained from a light cable with increased electrical resistance, although it may be carried out at a less original outlay, or from a shorter cable more costly per mile from increased strength and weight of iron, but with greater transmitting speed, and in consequence dividend earning capacity. But of equal importance with any of the previous points is the impossibility of grappling a light cable from any considerable depth in cases of injury affecting the insulation. To raise a cable from a depth of $1\frac{3}{4}$ miles involves a great strain upon the cable, and unless the breaking strain has been calculated to meet such an emergency, any successful attempt at restoration must be abandoned, and the entire line is rendered useless and the capital lost. Every submarine cable should be laid with a certain percentage of slack, regulated according to depth of water and surrounding circumstance. The average slack is from 8 to 14 per cent.

The first Atlantic cable, 1857, between Valentia and Newfoundland, is shown in elevation and section at Fig. 34. This cable, from imperfect construction, remained electrically sound for a very limited period, and very few messages were successfully passed through the conducting wire. It, however, became the pioneer to success, and elucidated several important points in connection with the design of the 1865 and 1866 Atlantic cables shown at Fig. 35. The covering of these cables consists of ten strands of Manilla hemp, each containing a homogeneous steel wire. The French Atlantic iron-sheathed cable between Brest and Saint-Pierre, laid in 1869, is shown at Fig. 36.

		Tons.
The weight of the main cable per naut is	...	1·652
,, intermediate ,,	...	6·246
,, shore ends ,,	...	20·447

(*To be continued.*)